Radioactivities in AMAMDA Modules

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Wide variations in the background (BKG) rates for photomultiplier tubes (PMTs) in AMANDA modules have been observed. The question naturally arises as to whether naturally occurring radioactivity in the glass envelope could explain these differences. To test this, one complete module as well as various glass envelopes were counted at the LBNL Low-Background Facility. Because of the low background nature of the concrete room of the facility, it is possible to count the module and the glass without completely encasing them in lead, as shown in Figure 1.

Measurements were taken on both hemispheres of the complete module. Values of 0.61±0.04 ppm U, 0.62±11 ppm Th, and 2.44±0.04% K were measured for the base side. Values of 0.46±0.04 ppm U, 0.71±10 ppm Th, and 2.21±0.04% K were measured for the cathode side. In terms of activities, this amounted to 4.5 d/sec U, 2.3 d/sec Th, and 550 d/sec K for the cathode side of the module. Clearly the large activity of K, 90% of whose decays produce electrons up to 1.35 MeV (with an average energy of 0.45 MeV) affect BKG rates in the PMT.

To better understand these results, several samples of glass were measured to determine the range of natural radioactivity present in the glass. As shown in the table at the bottom of this page, a wide variation of natural activities was observed, particularly in the activity for K, which contributes most to the counts in the PMTs. To minimize BKG rates, glass with low K content could have been selected, assuming acceptable mechanical and optical characteristics as well as acceptable cost.

Fig. 1. AMANDA Module 13-457 positioned on top of the GEM detector in the Low-Background Facility at LBNL.

						From 20cm x 20 cm area of glass		
Sample		**mass**	**ppm(U)**	**ppm(Th)**	**%K**	**dps(U)**	**dps(Th)**	**dps(K)**
13-457	Module (Cathode)		0.46(4)	0.71(10)	2.21(4)	4.5	2.3	550
13-457	Module (base)		0.61(4)	0.62(11)	2.44(4)			
Benthos-10	10" Hemi	2043	0.82(4)	0.54(8)	1.51(4)	8.	1.7	375
Billings-12	12" Hemi	2721	1.16(5)	0.46(8)	0.08(2)	11	1.5	20
McLane-01	12" Hemi	2963	2.40(5)	1.32(10)	0.16(2)	23	4	40
Nautilus	17" Hemi	8751	0.62(2)	0.89(5)	0.02(1)	6	3	5
Benthos pieces	17" Hemi	8700	0.61(2)	0.42(4)	0.46(2)	6	1.4	115
Benthos #1	13" Hemi	4493	0.37(3)	0.60(7)	0.66(7)			
Benthos #2	13" Hemi	4493	0.45(3)	0.62(8)	0.63(2)			